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Service

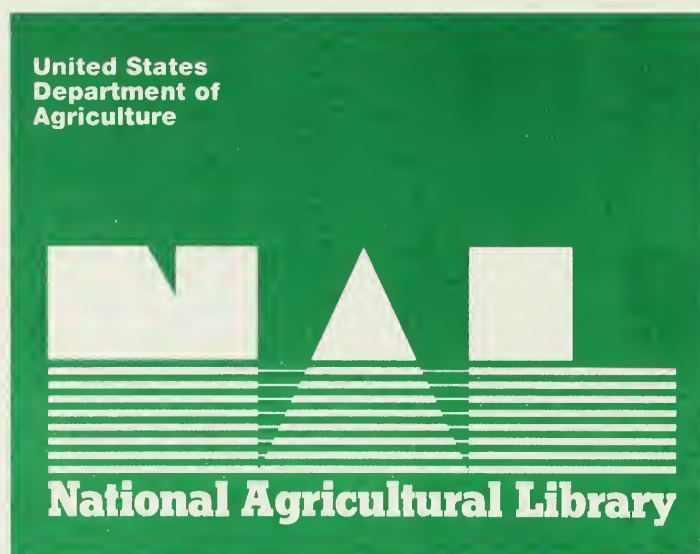
Energy Conservation and the Rural Home

Economic Considerations for the
Nation and the Individual

Dup.



This paper has been prepared by the National Rural Development Committee Staff to support efforts by State and local rural development committees. M. R. Janssen, Agricultural Economist, Economics, Statistics, and Cooperatives Service (ESCS), was the senior author.



Energy Conservation and the Rural Home

Economic Considerations for the Nation
and the Individual

Background

A century ago, oil was used primarily for lighting and lubrication. By 1900 we started to use petroleum to fuel automobiles, and by 1940 oil replaced coal as the predominant energy source. Natural gas originally was a discarded by-product of oil production. Only when pipelines delivered it cheaply nationwide did its use grow. Between 1945 and 1960, natural gas became the main fuel for residential heating. Its cleanness and low price induced industrial and residential users to switch from coal to natural gas. Natural gas provides one-fourth of U.S. energy needs (fig. 1).

From 1950 to 1970 the real 1/ cost of energy declined, and electricity at current higher rates is still below 1950 real prices. The real 1/ price of oil measured in terms of the Consumer Price Index was lower in 1972 than in 1950, but has increased by nearly 50 percent since that time. Only since 1975 have the real prices of natural gas risen above the 1950 level (table 1).

Domestic Energy
Consumption by
Type of Fuel,
1976

Percent

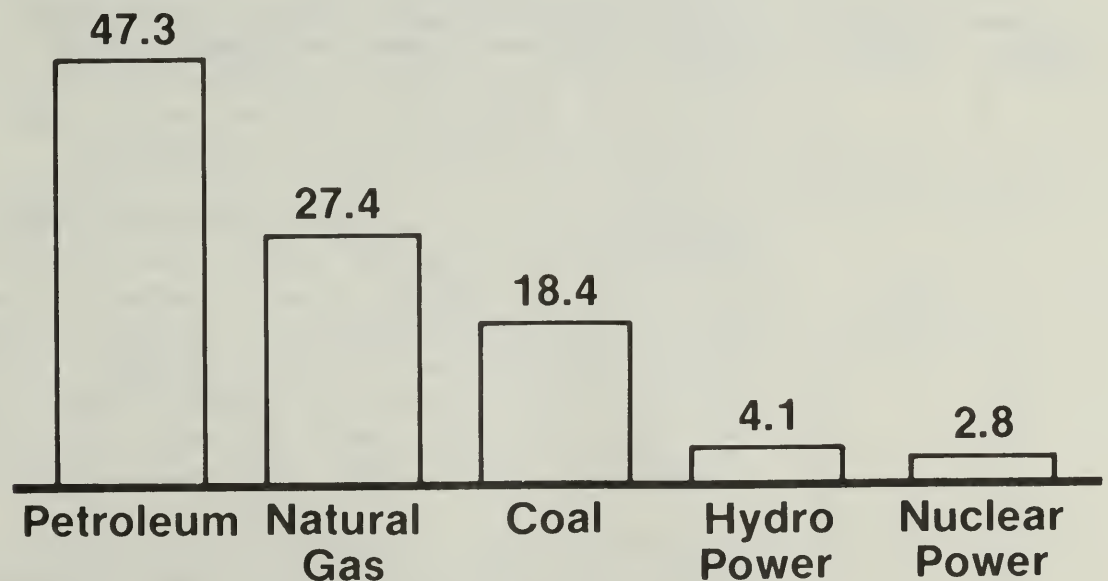


Figure 1

1/ Real cost; real price: Index of fuel prices divided by consumer price index, 1967 = 100.

Table 1--Index
of retail energy
prices, specified
years 1950-75
(Deflated by con-
sumer price index
to remove effects
of inflation)

| Year | : | Natural Gas | : | Electricity | : | Oil |
|------|---|--------------------|---|-------------|---|-----|
| | : | Index (1967 = 100) | | | | |
| 1950 | : | 101 | | 126 | | 100 |
| 1955 | : | 101 | | 120 | | 106 |
| 1960 | : | 110 | | 112 | | 100 |
| 1965 | : | 106 | | 105 | | 100 |
| 1966 | : | 104 | | 102 | | 99 |
| 1967 | : | 100 | | 100 | | 100 |
| 1968 | : | 97 | | 97 | | 98 |
| 1969 | : | 95 | | 94 | | 96 |
| 1970 | : | 94 | | 92 | | 94 |
| 1971 | : | 96 | | 93 | | 95 |
| 1972 | : | 99 | | 95 | | 93 |
| 1973 | : | 97 | | 94 | | 101 |
| 1974 | : | 98 | | 99 | | 144 |
| 1975 | : | 107 | | 104 | | 143 |

Source: Oak Ridge National Laboratory.

During 1950-75 household energy use for all purposes increased 140 percent, from 6.5 to 16.2 quadrillion British thermal units (Btu's), with a larger number of housing units and greater energy use per household. ^{2/} Most of this increase was in use of electricity and natural gas. Greater use of oil and LP gas occurred, while coal use declined to 2 percent of energy used in households.

During the same period, total domestic energy use more than doubled. Petroleum and natural gas provided 75 percent of our energy in 1975, up from 58 percent 25 years earlier. Domestic crude oil production peaked in 1970, and was 1.5 million barrels per day lower in 1975 (fig. 2). Domestic crude oil and natural gas reserves have also declined since 1970 (fig. 3). The number of wells drilled annually declined from 1955 to 1968, and regained 1965 levels in 1976.

In 1960 the Nation imported the equivalent of 1.8 million barrels daily of crude oil and refined products at a cost of 1.5 billion dollars annually (figures 4 and 5). By 1976, imports of 7.3 million barrels per day cost \$34.6 billion. The cost of imported oil and petroleum products has skyrocketed to over 22 times the 1960 level.

^{2/} A "quad" is 1 quadrillion Btu's of energy.

Oil drilling has increased in an effort to enlarge domestic supplies. But we will still need to shift to other sources of energy and limit our oil use for many reasons including the current U.S. deficit in balance of payments.

Domestic Demand
for Refined
Products and
Crude Oil
Production

Million Barrels per Day

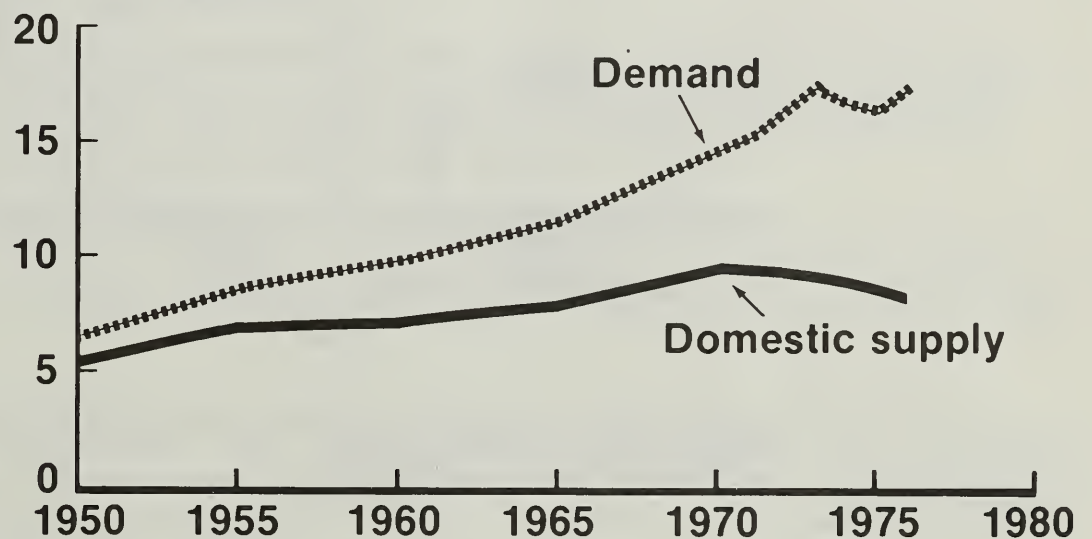
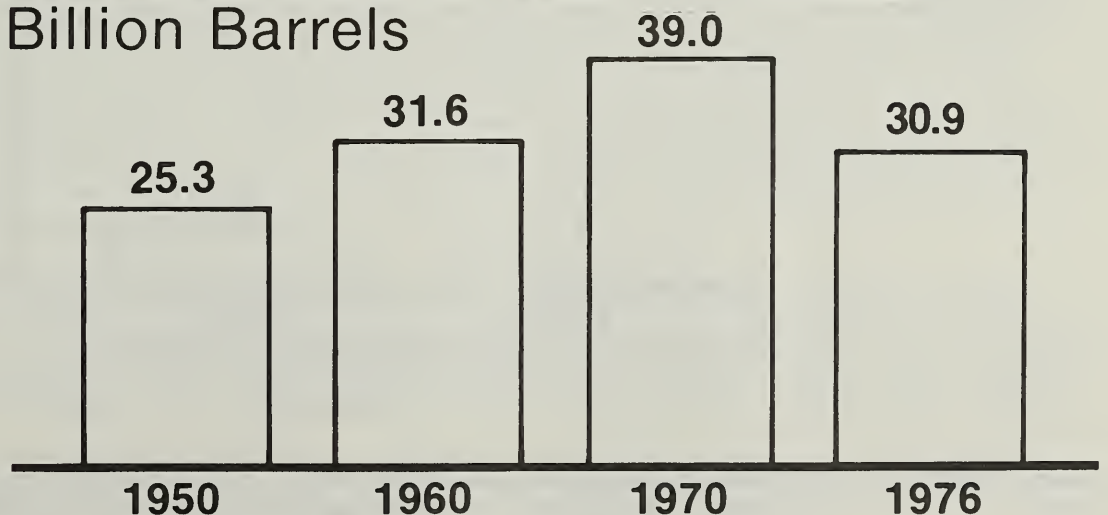


Figure 2

Domestic Crude
Oil Reserves

Billion Barrels

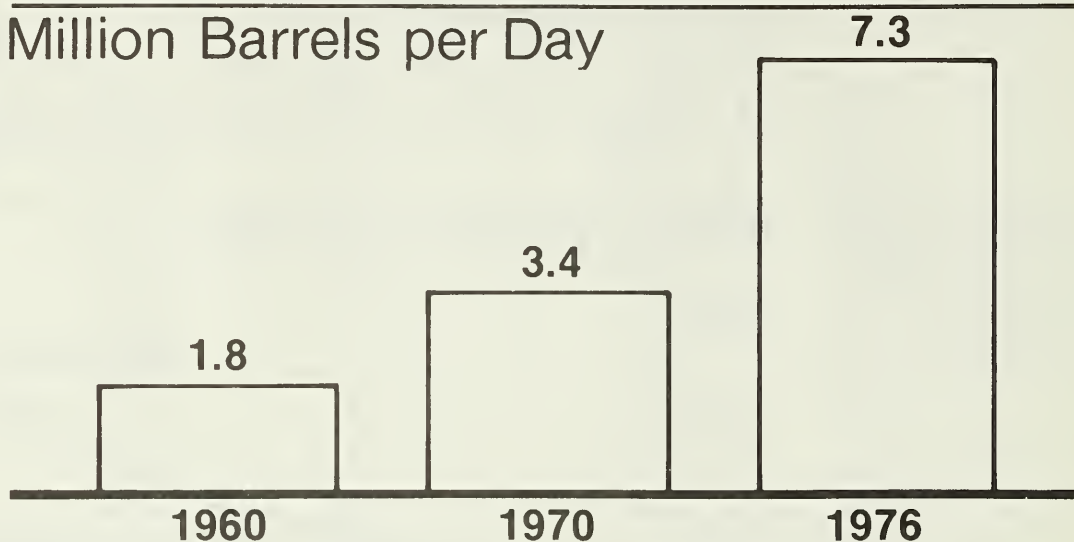


Source: American Petroleum Institute

Figure 3

Oil Imports by
United States

Million Barrels per Day

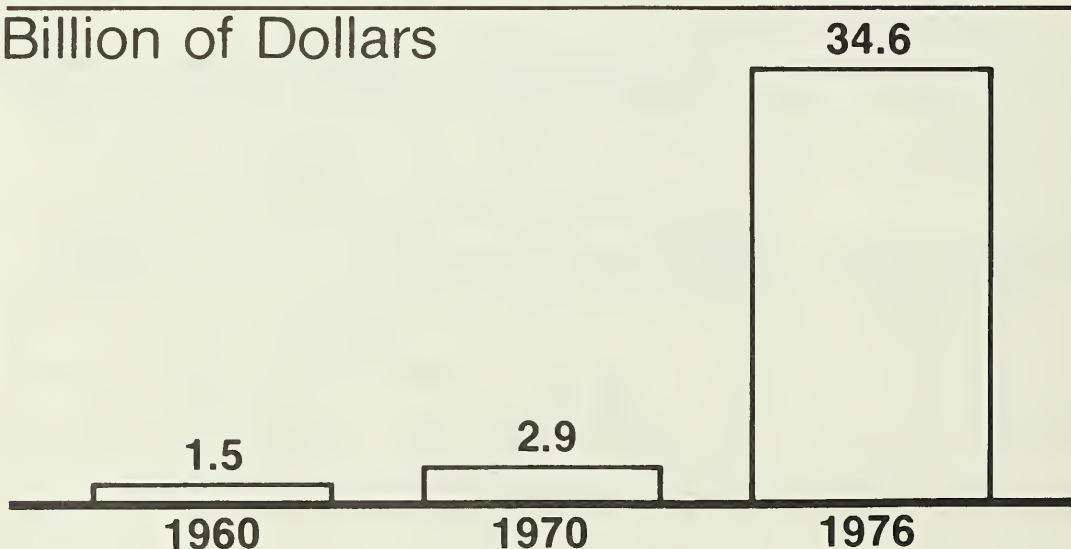


Source: Bureau of Mines

Figure 4

Value of
Oil Imports
by United States

Billion of Dollars



Source: U.S. Department of Commerce

Figure 5

Home Energy
Use

Home energy use demands 23.7 percent of the Nation's energy budget compared with only 2.9 percent for farm production. Fifty-nine percent of home energy use is for space heating. An additional 7 percent is for cooling and 14 percent is consumed to heat water. Rural areas, with nearly 23 million housing units, could save 1 quadrillion Btu's of energy

annually if 90 percent of the units were weatherized to meet minimum Federal standards by 1985. These savings are equivalent to 488,000 barrels of oil per day or 24.4 days of oil imports. These savings can be achieved by retrofitting existing homes at an average cost of \$550 (1975 prices), an amount homeowners could save on reduced fuel bills. The investment could be paid off in less than 5 years at 8 percent interest and in 6 years at 12 percent.

New housing construction has greater potential for savings, as more weatherization measures can be included during construction. New construction techniques promise additional savings without appreciable change in costs.

Space heating and air-conditioning account for 66 percent of the average energy use in a home. Nationwide this requires the energy equivalent of 5 million barrels of oil daily (fig. 6).

Nearly half the housing units in rural areas are heated by natural gas. Fuel oil is the next most popular fuel overall and the most widely used in the Northeast. Use of electricity is widespread, and is extensive in the Pacific Northwest and the TVA service area.

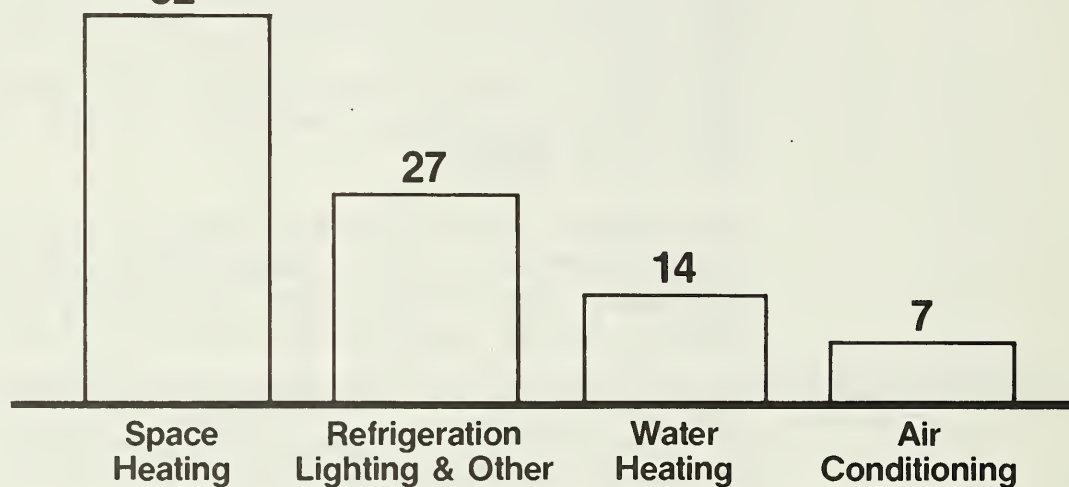
Oil and natural gas account for about equal shares of household energy use in rural areas (fig. 7). Oil is used extensively in northern areas with 8,000 degree days ^{3/}, while gas is used extensively in warmer areas with 2,000 to 4,000 degree days. Natural gas can be converted to heat more efficiently than oil. The average single-family dwelling with oil for fuel uses about 76 percent more energy than the one that uses natural gas.

Single-family homes that use electricity are usually better insulated than those using other fuels and require less energy. However, the efficiency of converting fossil fuel and transmitting it is only slightly over 30 percent. The gross amount

^{3/} Degree days equal the sum of Fahrenheit degrees that the daily average temperature is below 65 degrees F.

Residential Use
of Energy, 1975

Percent



Source: Oak Ridge National Laboratory

Figure 6

Energy Use for
Space Heating
Non-Metro
Housing Units,
1975

Quadrillion BTU's

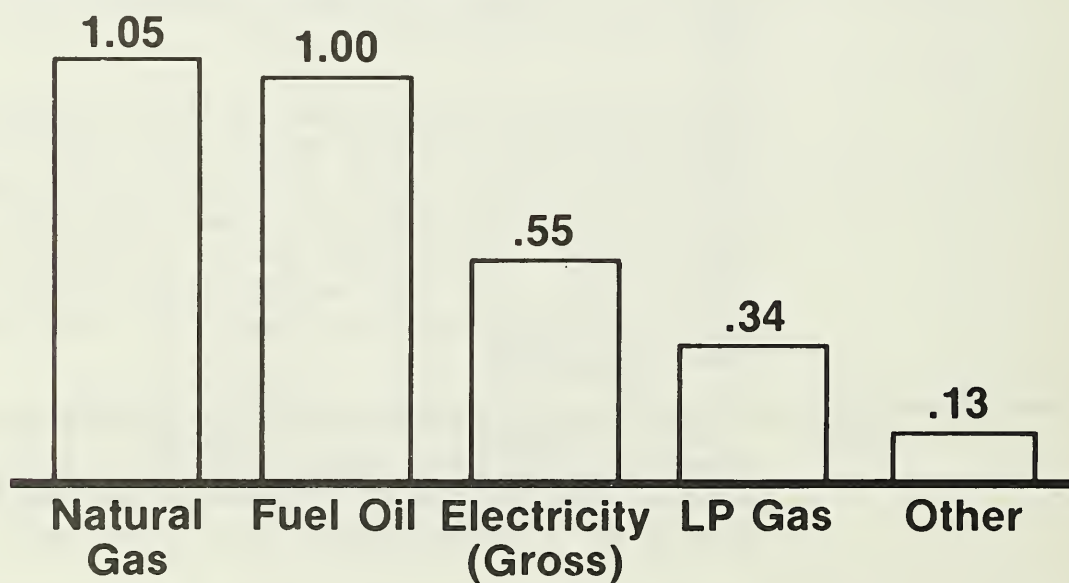


Figure 7

of energy required to heat the average home with electricity is similar to that required for heating a home with oil.

Direct fuel consumption in dwellings was 9.9 quadrillion Btu's (quads), 13.3 percent of total U.S. energy expenditures in 1976 (fig. 8). Electrical energy use added 6.8 quadrillion Btu's, or a total of 16.7 quads to heat and cool homes, heat water, and supply light and the other residential energy needs. This amounted to 23.7 percent of the Nation's energy use.

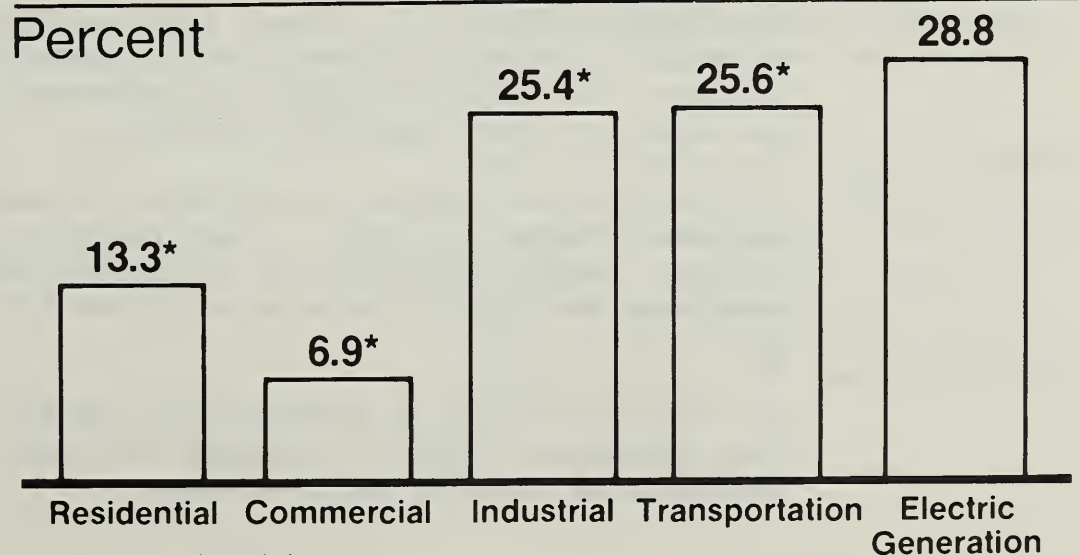
National Goal

One national goal, endorsed by the President, is to weatherize 90 percent of existing homes to minimum Federal Standards by 1985. If this objective is achieved, the energy saved in rural areas would be 1 quad, the equivalent of 178 million barrels of crude oil annually by 1985 (table 2).

The conservation effort in rural areas would save enough natural gas to heat over 4.3 million single-family dwellings. In addition, 54 million barrels of fuel oil would be saved. In all, energy savings in rural areas would equal 488,000 barrels of oil daily, representing 24.4 days of oil imports at 1976 import rates.

If you fully retrofit an average home, you can anticipate a 35-percent reduction in fuel use.

Domestic Energy Consumption by Economic Sector



*Excludes electricity.

Source: Federal Energy Admin., based on Bureau of Mines data

Figure 8

Table 2--Projected savings that could result from the weatherization of 90 percent of the housing units in rural areas by 1985 a/

| Energy or Fuel | : | Unit |
|--|---|----------------------|
| Estimated total energy consumed annually | | 3,171 trillion Btu's |
| Estimated savings, 1985 | | 999 trillion Btu's |
| Equivalent crude oil saved annually | | 178 million barrels |
| Daily savings (equivalent crude oil) | | 488 thousand barrels |
| Annual savings equals 24.4 days of oil imports (1976 rate) | | |

a/ A nonmetropolitan area is an area outside counties with cities of more than 50,000.

Weatherizing Our Homes

Homeowners can set priorities according to their budget in weatherizing their homes. Caulking, weatherstripping, and insulating exposed heat ducts may be high on their list. These low-cost measures can be repaid in a short time. Insulation for wall, attic, and floors over unheated areas may be the next consideration.

A high proportion of U.S. homes are inadequately insulated. Although 70 percent of these housing units have some attic insulation, the material usually is compacted, inadequate to begin with, or often improperly installed.

If the attic and floors are partially insulated, storm windows may have a higher priority. Storm doors are not quite as important. Added insulation for air-conditioning may benefit residents that live in an area with over 500 hours of cooling.

4/

The National Bureau of Standards and the Oak Ridge Laboratory have developed a model to estimate the costs and benefits of weatherizing existing and new homes.

4/ Hours of cooling: Annual hours outside temperature is over 80 degrees F.

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CNTL: 4394234 Rec stat: n Entrd: 781122 Used: 000000
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1. 086 0 A 105.2:En 2
2. 110 10 United States. \b Dept. of Agriculture. \b National Rural Development Committee.
3. 245 10 Energy conservation and the rural home : \b economic considerations for the nation and the individual / \c [prepared by the National Rural Development Committee staff ; M. R. Janssen, senior author]. --
4. 260 0 [Washington] : \b Dept. of Agriculture, Economics, Statistics, and Cooperatives Service, \c 1978.
5. 300 12 p. : \b ill. ; \c 26 cm.
6. 500 Issued June 1978.
7. 500 Cover title.
8. 650 0 Dwellings \z United States \x Energy conservation.
9. 650 0 Housing, Rural \z United States.

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They have also developed ways to estimate the amount of insulation that is most economical. If heating fuel is relatively inexpensive, it is advantageous to use only 6 inches of loose fill fiberglass insulation in the attic (table 3). However, if fuel is expensive, it is appropriate to use 14 inches.

Table 3--The relationship between fuel prices (1974) and the most economical amount of insulation needed to insulate an attic

| Cost of heating oil, cents per gallon | : | Loose fill fiberglass attic insulation, inches |
|--|---|---|
| 15 | : | 6 |
| 30 | : | 9 |
| 44 | : | 11 |
| 59 | : | 14 |
| 89 | : | 17 |
| 118 | : | 20 |
| | : | |

Source: National Bureau of Standards and Department of Energy.

In yet another location, the Virginia Electric Power Company (VEPCO) recorded 40 electrical homes in Northern Virginia where attic insulation had been installed. The households achieved an average annual reduction of 16 percent in all electrical use including space heating. Since heating energy is only a portion of the total electricity used in the home, about 25 percent of the energy to heat the home was actually saved.

Climate

The climate greatly influences how economical energy conservation measures are. In the climatic zone with 2,000 degree days and 1,500 cooling hours, typical of Jackson, Mississippi, the types and quantity of insulation applied will depend on air conditioning. With heating and no air-conditioning, 6 inches of attic insulation will be recovered in 5 years when heating oil is 59 cents per gallon. But with heating and air-

conditioning, the cost of 10 inches will be recovered in 4 years (table 4). With heating only, attic, wall, and duct insulation plus storm windows of 3x3 feet or larger would be recovered in 12 years or less. The cost of storm windows do not increase proportionately with size. Therefore, with air-conditioning, costs of storm windows 2x3 feet or larger will be recovered within 7 years.

Other Energy
Conservation
Steps

Other practices can save energy, and many require only a change in habits. Thermostat settings that minimize the differential between indoor and outdoor temperatures will limit heat loss. Humidity control may permit lower settings. Closing doors and minimizing the number of times they are opened will also restrict heat losses. A carpet with a heavy pad on the basement floor can improve comfort. Closing off unused rooms reduces the exposure of heated surfaces to outdoor temperatures. Judicious use of blinds and draperies can reduce heat loss while allowing the sun to warm the home in winter.

You can reduce water heating costs by adding insulation to the heater. A lower temperature setting will reduce the energy required to raise the temperature of water, improve the heating efficiency, and reduce energy losses. Hot water energy losses are especially important in hot weather when air conditioning is used to remove heat lost from the water

Table 4--Cost recovery time for installing specified attic insulation in different climatic zones, medium fuel costs a/

| Degree days | : | Heating | : | Heating & cooling |
|----------------------------|---|---------|--------|-------------------|
| | : | Inches | :Years | : Inches : Years |
| 2,000 (Jackson, Miss.) | : | 6 | 5 | 10 4 |
| 4,000 (Washington, D.C.) | : | 10 | 3 | 12 3 |
| 6,000 (Omaha, Nebr.) | : | 12 | 2 | -- -- |
| 8,000 (Minneapolis, Minn.) | : | 16 | 2 | -- -- |

a/ Fuel oil cost of 59 cents per gallon.

Source: National Bureau of Standards and Federal Energy Admin.

heater. Whenever possible, buy equipment that is energy efficient.

Clean the filters on your hot air circulation system to permit free movement of the air over the heat exchanger. This will increase the volume of air and permit a maximum transfer of heat from the furnace to the air in the system.

How efficient is your heating unit itself? An oil furnace that is 50 percent efficient would require 14.4 gallons of fuel to deliver a million Btu's of heat. One that is 70 percent efficient would use only 10.3 gallons to produce the same amount of heat. The efficient unit burns 29 percent less fuel than the inefficient one.

Well placed deciduous trees can keep the home cool in summer and permit sunshine to enter in winter. Grading and landscaping, too, can save on heating and cooling. Windbreaks in open country can reduce wind and cut home energy losses.

Let the economic incentives move you to weatherize your home. Help the Nation reduce its vulnerability to oil supply interruption.

Table 5--Number of occupied housing units using specified types of heating fuel, rural areas, 1975

| Heating fuel : | Single-family : | Multi-family : | Mobile : | Total |
|-----------------|-----------------|----------------|----------|-------|
| <u>Millions</u> | | | | |
| Natural gas: | 8.0 | 1.4 | .6 | 10.0 |
| L.P. gas : | 2.5 | .07 | .6 | 3.17 |
| Fuel oil : | 4.2 | .6 | .5 | 5.3 |
| Electricity: | 2.5 | .5 | .3 | 3.3 |
| Other : | 1.0 | .06 | .02 | 1.08 |
| : | | | | |

Source: Housing, Survey, 1975

USDA

The U.S. Department of Agriculture is especially interested in improving home weatherization in areas outside the counties with cities of more than 50,000 people. These areas include nearly 23 million of the Nation's 70.4 million housing units (table 5).

The Farmers Home Administration (FmHA) has proposed regulations that will require more insulation than presently required as a condition for a loan on new rural housing. The Farmers Home Administration and the Rural Electrification Administration have a program for rural electric cooperatives to aid members in financing weatherization measures.

The Need to
Shift

One short-term objective nationally is to reduce our dependence on foreign oil and vulnerability to supply interruptions. The longer term objective is to use renewable and inexhaustible energy sources for sustained economic growth.

The increasing world demand for fossil fuels, especially oil, has brought the energy problem to world attention. Cheap energy is a thing of the past. Prices can be set by the Oil Producing and Exporting Countries (OPEC). We clearly need to conserve fuel as a nation and to develop all alternative energy resources to reduce a continued heavy dependence on imported oil.

When more fuel is needed for residential heating, we use imported oil. Thus, when natural gas or electricity is in short supply, oil becomes the replacement fuel.

Eventually the United States will need to shift to more abundant fuels such as coal or utilize other sources of energy such as nuclear, solar, or hydroelectric power. We may also use fuels developed from renewable biological products or wastes. Until we can shift to other energy sources that are renewable or more plentiful, conservation will be especially important.

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